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ABSTRACT

This study assesses the effects of visual and verbal rehearsal on the problem solving efficiency of preschool children. The study examines the use of stimulus pretraining designed to induce verbal rehearsal and compares the effectiveness of induced verbal rehearsal with the effectiveness of induced visual rehearsal. Fifty-four middle class preschool children with a mean age of 61.4 months were assigned to one of three conditions: (1) verbal rehearsal, (2) visual rehearsal, and (3) control. Children in each condition participated in a stimulus pretraining session followed by a concept discovery task presented in the blank-trials format. Results indicated that visual rehearsal led to greater solution performance and more hypothesis testing than did verbal rehearsal, and to the use of hypothesis-systems rather than position-dominated response patterns across blank-trial probes. It is suggested that the visual rehearsal procedure used in the training sessions provides a useful operational definition of the visual rehearsal process.
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**Induced Visual and Verbal Rehearsal and Problem-
Solving Efficiency in the Preschool Child**

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Induced Visual and Verbal Rehearsal and Problem-Solving Efficiency in the Preschool Child

It is well established that preschool and primary grade children show relatively inefficient problem-solving strategies in tasks involving concept formation. For example, compared to older children who are administered a blank-trials, concept discovery task, preschoolers show (a) a lower level of hypothesis testing, (b) less consistency in the correct use of both positive and negative feedback, (c) essentially no response patterns that reflect hypothesis testing sequences, and (d) fewer correct solutions by the end of the task.

One explanation for this age effect in problem-solving efficiency has been offered by Gholson, Levine, and Phillips (1972). Specifically, this explanation attributes young children's poor problem solving to their deficiencies in subprocesses that underlie the use of logical rules used during the task. Memory is one such subprocess that is known to change with age and has been shown to influence problem-solving in young children. Several studies, for example, have shown that providing second-grade children with memory aids facilitates their problem-solving

efficiency as measured by the use of strategies (cf. Eimas, 1970; Gholson, et al., 1972). However, the effects of other mnemonic components on problem solving are not so well known. This paper describes a study that was conducted to assess the effects of one aspect of memory, rehearsal, on the problem-solving ability of preschool children.

The use of a rehearsal process in memory is known to change with age. Young, preschool and primary grade children tend not to rehearse spontaneously (cf. Flavell, Friedrichs, & Hoyt, 1970) when presented with lists of to-be-remembered items, although Hagen and others (cf. Kingsley and Hagen, 1969) have shown that these same children can be trained to use cumulative, verbal rehearsal strategies to increase their retention. Researchers who have studied the rehearsal process have studied it primarily as a verbal one. Recently, several theorists have suggested that rehearsal may also occur in a visual modality (Morrison, Holmes, and Haith, 1974; Liben & Drury, 1977). The visual rehearsal process, however, has not been operationally defined and its effects on information processing have not been examined systematically.

With respect to the effect that rehearsal may have on problem-solving efficiency, it would seem that unless information relevant to problem solution is rehearsed, the problem solver will forget task related information. The loss of such information may seriously impede problem solution and predispose the subject to rely upon less efficient problem-solving strategies or non-hypothesis-testing response patterns.

Thus, the present study was designed to examine whether the induction of both types of rehearsal would enhance the problem-solving strategies of preschool children. Because past research has demonstrated that induced verbal rehearsal increases the level of young children's retention, it was thought that stimulus pretraining designed to induce verbal rehearsal in these children might also increase their problem-solving efficiency. Furthermore, because preschool children seem prone to store information in a visual code (cf. Brown, 1977; Hayes & Shultze, 1977), it was thought that an induced visual rehearsal of information relevant to problem solution would facilitate the young child's problem solving more than induced verbal rehearsal.

In order to test these hypotheses, 54, middle-class,

preschool children (mean CA = 61.4 months, S.D. = 8.17 months) from the greater Bangor, Maine area were assigned to one of three conditions. The general nature of these conditions is outlined in Table 1. As is apparent in the table, children in each condition were subjected to a stimulus pretraining session followed by a concept discovery task presented in the blank-trials format. In the verbal rehearsal condition, subjects were pretrained to rehearse cumulatively and verbally the dimensional values among stimuli in a problem-solving set. In order to examine the effects of visual rehearsal on problem solving, a procedure was developed to induce visual rehearsal in a manner analogous to that used for inducing rehearsal in a verbal modality. Subjects in the visual rehearsal condition were pretrained to rehearse visually by constructing replicas of stimuli. By using one of two color cards, pattern transparencies, and size/shape stencils, it was possible to construct all of the stimuli used in the problem-solving set. Subjects in a control condition were pretrained to discriminate tactual, non-task related stimuli during stimulus pretraining.

Following stimulus pretraining, children were introduced to

the problem-solving task. On each trial of this task, children selected from sets of paired, orthogonal stimuli, the stimulus figure that they believed contained the experimenter defined concept. All problems were defined by simple, one-attribute answers. Two pretraining problems introduced the task and the idea that on some trials no feedback would be given. The two pretraining problems were followed by three test problems on which feedback was presented on the first and thereafter every fifth trial. On the test problems, stimuli presented on blank-trial sequences were arranged so that a subject's left-right pattern of responding indicated the use of simple hypotheses. Each problem consisted of 46 trials. During test problems, children in the visual and verbal rehearsal conditions were required to rehearse overtly dimensional values of the positive stimulus instance on the first and thereafter every third outcome trial.

Results and Discussion

Several dependent measures were used to assess problem-solving efficiency. Two of these were the percentages of correct choices on the last, seven outcome trials of a problem and the number of hypothesis-testing patterns exhibited on blank-trial probes. Table 2 summarizes these data. As is suggested by the

data, the most efficient problem solving occurred following visual rehearsal pretraining. This impression is confirmed by major analyses conducted using ANOVA techniques with Pretraining Condition as the major between-subjects factor and Problem and List Order as the major within-subjects factors. Analyses revealed a significant main effect for Pretraining Condition for (a) the percentage of correct choices on final outcome trials, $F(5, 96) = 3.17, p < .05$,¹ and (b) the use of hypothesis-testing patterns, $F(5, 96) = 3.79, p < .01$.¹ Subsequent post hoc analyses using Duncan's Test revealed that children pretrained to rehearse visually were correct on the final outcome trials of problems more often than children pretrained in the control condition. Furthermore, children in the visual rehearsal condition used significantly more hypothesis-testing patterns per problem than did children pretrained in the verbal rehearsal condition.

Significant differences were also found between conditions with respect to the types of response patterns that were used over consecutive blank-trial probe sequences. Children in the control and verbal rehearsal conditions tended to use position perseveration response patterns, whereas children in the

visual rehearsal condition tended to use more random, hypothesis response sequences. In the random, hypothesis response sequence, simple hypotheses are tested on blank-trial probes, however the manner in which they are tested can not lead to solution. The use of these random patterns has been suggested to reflect a more sophisticated approach to problem-solving tasks that is transitional between the use of nonhypothesis-testing patterns and hypothesis-testing patterns with a solution-achieving nature (cf. Gholson, O'Connor, & Stern, 1976).

The major finding of this study is that visual rehearsal, as manipulated in this study can affect aspects of the preschool child's problem-solving process. Furthermore, visual rehearsal pretraining was consistently more beneficial to the preschool child than was verbal rehearsal pretraining.

Although visual rehearsal pretraining facilitated aspects of information processing efficiency, it was also found that it, as well as the other two conditions, failed to induce the use of hypotheses that were consistent with previous outcome information and hypothesis-testing patterns that were solution-achieving in nature. One possible explanation is that children in this study may have misperceived the nature of the problem-

solving task. The intermittent rehearsals required of subjects during the test problem may have cued subjects to view the blank-trial task more as a mnemonic game than as a problem solving one. One other possible explanation of the rehearsal conditions' failure to produce solution-achieving strategies is that the rehearsal procedure may have induced a rehearsal strategy that was inappropriate for maintaining outcome information over a relatively long retention interval. The kind of rehearsal required of subjects in this study is best described as Type I rehearsal, i.e., a repetition of values without reference to their importance or meaning to the criterion task. Recent research suggests that maintenance rehearsal is effective for retaining information over brief periods of time only (cf. Ferguson & Bray, 1976). Within the blank-trial task, the problem solver must retain outcome information over a relatively long period of time, i.e., the blank-trial sequence. Such retention intervals may lead to a loss of solution-related information due to a failure to rehearse outcome information in such a manner (e.g., elaborative rehearsal) that it is more resistant to forgetting.

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Footnote

1. The three conditions reported in this paper were a subset of six conditions manipulated in a larger study.

Table 1

A Description of Pretraining and Testing Conditions

Conditions	Pretraining	Testing
Verbal Rehearsal	Subjects verbalized all of the dimensional values in a stimulus instance and repeated that statement two additional times in the absence of the stimulus	On the first and thereafter every third outcome trial, subjects verbalized all of the dimensional values of the positive stimulus instance and repeated that statement two additional times in the absence of the stimulus
Visual Rehearsal	Subjects constructed replicas of stimulus instances using color cards, pattern transparencies, and shape/size stencils. Each construction was repeated twice in the absence of the stimulus.	On the first and thereafter every third outcome trial, subjects constructed replicas of the positive stimulus instance. Each replica was constructed two additional times in the absence of the stimulus.
Control	Subjects were presented with a tactile discrimination task. Given two alternatives, children selected a match for a probe stimulus.	Subjects were delayed with the positive stimulus remaining in view for five-seconds prior to the presentation of the next stimulus.

Visual and Verbal Rehearsal

12

Table 2

Mean Percentage of Correct Choices on Last Seven Outcome Trials,
Mean Number of Hypotheses, and Predominant Response Pattern

Condition	Percentage of Correct Choices	Mean Number of Hypotheses	Predominant Response Sequence
Verbal			
Rehearsal	52.4%	3.09	Position Perseveration
Visual			
Rehearsal	54.8%	4.79	Random
Control	47.9%	3.56	Position Perseveration